IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 15, Issue 10 Ver. VIII (October. 2016), PP 76-84
www.iosrjournals.org

Original article

A Comparative Study of Magnetic Resonance Imaging And Transrectal Ultrasonography in Patients With Elevated PSA Levels And HPE Correlation with TRUS Biopsy.

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Abstract: *Prostate cancer is the second most common carcinoma in men which is very difficult to diagnose by conventionall imaging techniques. Nowadays with the help of Transrectal ultrasound and MRI, the lesions can be picked up very easily and image guided biopsy can be done.*
Objective: *The purpose of our study was to evaluate the patients above 40 years, with prostatic complaints and categorize prostatic diseases as benign and malignant depending on their Transrectal sonographic appearances,to evaluate various prostatic lesions depending on their MR signal characteristics and to do TRUS guided biopsy of suspicious lesions and to confirm by histopathology.*
Materials and Methods: *A prospective study of 50 patients between the age group 41-78 years who came to the Urology/Surgery Department, Meenakshi Medical College Hospital, Kanchipuram between May 2011 - September 2014, with prostatic complaints like hesitancy, poor stream, acute retention of urine, urgency, urge incontinence, nocturia and increased levels of PSA(>2ng/ml) was done. The study was started after taking prior clearance and permission from the ethical committee. After taking thorough history and detailed clinical examination including Digital Rectal Examination (DRE), Transrectal sonography (TRUS), MRI of Pelvis and TRUS guided biopsy. Findings of each modality were compared with HPE results.*
Results: *out of 50 cases, 32 were bening prostatic hyperplasia(BPH), 7 were carcinoma prostate, 4 were abscess, 2 were prostatic cyst and 5 were inconclusive.*
Conclusion: *Transrectal ultrasound is minimally invasive, easily available and accurately localize the lesions for biopsies. MRI is also a safer modality with good resolution to diagnose the lesion at earlier stage, to assess the local staging such as extracapsular extension and to identify the pelvic bone metastasis.*
Keywords: *BPH; PSA; TRUS; Prostate;*

I. Introduction

The prostate is a small organ situated deep in male pelvis and is the organ most prone to pathological change. Indeed, all men who live past the age of 50 will develop histological change within the prostate, most common process being BPH. Many older men also develop prostate cancer the second most common carcinoma in men.

The American Cancer Society estimates that in 2004, 230,110 new cases of prostate cancer will be diagnosed in the United States and 29,900 people will die of the disease, increases of 4.5% and 3.5%, respectively, compared with 2003 data (American Cancer Society. Cancer facts and figures 2004. Publication No 5008.04.). Because of the advent of prostate-specific antigen (PSA) screening, most prostate cancers are now diagnosed at an earlier stage. At present, 86% of newly diagnosed prostate cancers are localized within the gland and patients have a 5-year relative (i.e., adjusted for life expectancy) survival rate of 100%. The 5-year relative survival rate for all stages of prostate cancer is 98%, which indicates that prostate tumours have a slow growth rate and allow for prolonged survival, even in patients with metastases at diagnosis.

With the advent of Transrectal sonography we are able to get a detailed view of prostate. As we are using high resolution transducers with high frequency ranges and sharply focused near fields, we are able to

appreciate zonal anatomy of prostate, the lesion distribution, to characterize various prostatic lesions and helps in taking biopsies underguidance.

Magnetic resonance imaging helps us to get multiplanar views of the prostate along with adjacent structures in the pelvis. Also it is able to clearly delineate the zonal anatomy especially with Endorectal coil.

II. Objective

i.To evaluate the patients above 40 years, with prostatic complaints like hesitancy, poor stream, acute (A/c) retention of urine, urgency, urge incontinence, nocturia and/or with elevated PSA (>2ng/ml) and categorize prostatic diseases as benign and malignant depending on their Transrectal sonographic appearances.

ii.To assess the role of colour Doppler in localizing and differentiating prostatic lesions.

iii.To evaluate various prostatic lesions depending on their MR signal characteristics.

iv.To do TRUS guided biopsy of suspicious lesions and to confirm by histopathology

III. Materials And Methods

A prospective study of 50 patients between the age group 41-78 years who came to the Urology/Surgery Department, Meenakshi Medical College Hospital, Kanchipuram between May 2011 - September 2014, with prostatic complaints like hesitancy, poor stream, acute (A/c) retention of urine, urgency, urge incontinence, nocturia and increased levels of PSA(>2ng/ml) was done. The study was started after taking prior clearance and permission from the ethical committee.

After taking thorough history and detailed clinical examination including Digital Rectal Examination (DRE), we have done transabdominal ultrasound scan first and were then subjected to Transrectal sonography (TRUS). Colour Doppler was also used in evaluating the lesions. TRUS was performed using ALOKA -3500 equipped with 7.5 MHz Transrectal probe. Next MRI was done using SIEMENS 1.5T superconducting magnetom, using pelvic phased array coil. After obtaining informed written consent patient was subjected to TRUS guided biopsy using Bard max core biopsy needle 18 g x 25 cm length with a penetration depth of 22mm and a sample notch of 18mm.

Inclusion Criteria:

All the patients in the study were referred from Urology Department /Department of general surgery with symptoms of prostatic enlargement like frequency, urgency, urge incontinence, hesitancy and/or with elevated PSA levels(>2ng/ml). Broadly the patients included fall into the following criteria.

i. Diffusely enlarged prostate as per DRE

ii. Patients with elevated total PSA(>2ng/ml).

iii. Patients with hard prostatic nodule.

iv. Patients having tender enlarged prostate.

v. To evaluate those patient with osteoblastic bone secondaries.

Exclusion Criteria:

i.Patients not willing to undergo TRUS &MR Examination Patients with MR incompatible devices/implants

ii.Those patients who are unable to lie down in supine/lateral position.

iii.Patients with claustrophobia.

iv.Those patients who are not operated or non-availability of HPE report.

Biopsy criteria:

Patients showing features of BPH were subjected for Trans- urethral resection of prostate and specimen sent for HPE.

Patients showing inhomogeneous echotexture of prostate and nodular lesion irrespective of their zonal distribution were subjected for USG guided biopsy of prostate through transrectal route.

IV. Results

Our study included those patients having prostatic problems or palpable nodules in the prostate detected by digital rectal examination and/or patients with elavated PSA(>2ng/ml).

They were between age groups 41-78 years.

After taking thorough history and detailed clinical examination, we have done transabdominal scan first.Then we examined 50 patients by transrectal sonography with colour Doppler and MR examination.

All patients were classified depending on the sonographic appearance of prostate into various groups as follows:-

Group - 1: Enlarged prostate showing homogenous echotexture 28/50
Group - 2: Enlarged prostate showing inhomogenous echotexture 7/50.
Group - 3: Prostate showing nodular lesions 8/50
Group - 4: Tender enlarged mixed echogenic prostate with cystic areas 5/50.
Group - 5: Prostate showing echolucent cystic lesions without septations 2/50.

All Group 1 patients were assigned as benign prostatic enlargement and were sent for transurethral resection of prostate. No histopathologic results were reported as malignancy.

All Group 2 and Group 3 patients were subjected for guided biopsy of prostate. 15 were subjected for guided biopsy of which 6 results came as malignancy 4 as benign and 5 turned to be negative biopsy (Inconclusive).

All Group 4 patients were treated with a course of antibiotics and they were re-examined with transrectal sonography. Repeat examination shows reduction in the size of lesions in 4 patients, and 1 patient did not show any size reduction and he was subjected for biopsy. Biopsy turned out to be malignant.

All group 5 patients are assigned as cases of prostatic cyst and no treatment offered for them.

By ultrasonographic examination we assigned 28 patients as cases of BPH. Biopsy results of 2 nodular lesions and 2 prostate showing inhomogenous echoes turned out to be benign.

Out of 8 nodular lesions 4 presented as hypoechoic nodules in the peripheral zone. Two lesions were isoechoic nodules with diffuse involvement of prostate with loss of normal zonal anatomy and surface irregularity, and 2 other lesions were hyperechoic nodule in transition zone.

Of these lesions we suspected 6 as malignancy because of surface irregularity and because they were in the peripheral zone, 2 lesions as inconclusive, of which 5 tuned out to be malignant, and 2 as benign. One biopsy from group 4 turned out as malignant.

The ability of TRUS to localise & to diagnose various benign and malignant lesions depending on their sonographic features were compared with HPE results using various statistical tests.

McNemar's and Chi square test were used to evaluate whether there is any significant difference between TRUS and HPE results.

V. MRI Results

Taking nodular hypointense lesion in peripheral zone, with or without capsular breech as MR features suggesting malignancy, out of 8 patient 5 were assigned as malignant. More over MR picked up one patient with capsular breech which was not seen in TRUS.

Group I patients showed enlarged gland with mixed intense transition zone with normal hyperintense peripheral zone.

In Group II patients enlarged gland with mixed intense signal were noted in transition & central zone. But no e/o capsular breech and surface irregularity were seen. Hyper intense peripheral zone also appeared normal.

In Group IV patient, MR showed mixed intense lesion in T2 WI with irregular walls involving diffusely.

In Group V patients MR showed well defined hyperintense lesion in the centre of gland with normal peripheral areas.

In group III patients 5 of 8 patients showed hypointense nodular lesions involving the peripheral zone. 3 of which showed capsular breech and 1 patient also showed adjacent femoral, iliac bone and vertebral body involvement and of the other 3 in 2 patients mixed intense nodular lesions were noted in central gland and in 1 patient no nodule was detected in MR.

The ability of MRI to detect the various benign and malignant lesions depending on their signal characteristics were compared with HPE results using various statistical tests. McNemar's and Chi square test were used to evaluate whether there is any significant difference between MRI and HPE results.

VI. Discussion

Although prostate cannot be directly visualized by conventional methods, Intravenous urography and cystourethrography can show the prostatic impression in the floor of the urinary bladder. The urethra may be elongated and it appears compressed, looking like a slit on A.P. View.

During ascending urethrogram or voiding cysto-urethrogram it may produce a smooth filling defect in the floor of the bladder. At times intra-vesicle filling defect may be produced by enlargement of the periurethral and subvesicular part. I.V.U. may shows J-Shaped (fishhook deformity) distal ureters due to enlarged prostate pushing the bladder trigone upwards.

Early prostatic cancers cannot be picked up by conventional contrast studies or by transabdominal ultra sonography of the prostate. However in late stages when the prostatic carcinoma extends towards the urethra, irregular Contour of prostatic urethra and bladder base can be seen in voiding cystourethrography.

If seminal vesiculogram is performed the medial portion of the seminal vesicle are seen to be decrease in size, related to tumour infiltration and lateral portion of seminal vesicle may be dilated. The junction between the ductus deferens and the lateral part of seminal vesicle may also be dilated, and the junction between the ductus deferens and the ejaculatory duct may be depressed. Contrast medium may have a greater tendency to flow distally rather than back into the bladder when entering the posterior urethra from the ejaculatory duct.

On transabdominal ultrasonography prostate appears as a homogenous, round to slightly ovoid structure, with uniform, low level echoes. The relationship between the bladder and the prostate can be demonstrated. But the normal zonal anatomy of the prostate cannot be demonstrated. Early hypo echoic cancers in the peripheral zones cannot be picked up. The prostate and periprostatic tissue are well visualized using computed tomography. But neither the zonal anatomy nor the differentiation between the prostatic parenchyma and the prostatic capsule were visualised.

On magnetic resonance imaging the ability to demonstrate the zonal anatomy of the prostate and the distinction between the gland and periprostatic tissue varies with the imaging plane and sequences used .On spin echo T1 WI, regardless of field strength, the prostate shows a homogenous signal of intermediate intensity and the zones cannot be differentiated .On T2 WI the zonal anatomy is well delineated with prostatic urethra as a key point .Endorectal coil MRI is the imaging modality of choice at present for detecting and accurate staging of prostate cancer but it is much costlier and is not available in all places.

Robert L, Bree et al described that the sonographic appearance of BPH is varied and depends on the histopathological changes. Diffuse enlargement of the transition zone with homogenous echoes will be seen in fibromuscular hyperplasia, inhomogenous echoes, in cases showing combination of fibromuscular and adenomatous element, hyperechoic nodules in cases of prostatic adenoma[1].

In our series out of 32 cases of BPH, 28 patients[87%] showed diffuse homogenous hypoechogenicity of transition zone, 2 patients [6.25%] showed hyperechoic nodules in the transition zone. 1 patient [3.1%] showed inhomogenous echotexture of transition zone.

Mathew D. Rifkin et al reported presence of smooth and regular capsule as a sign of benign lesion. In his series 93% cases of BPH had a smooth capsule. In our series all 32 cases [100%] of BPH had smooth and intact capsule[2].

R.Malik et al in his study showed sensitivity &specificity of TRUS to diagnose carcinoma prostate to be 87%and72% respectively, our study showed a sensitivity of 86% and specificity of 90%[3].

Fred Lee et al in his series reported 8 hyperechoic nodules of which 7 were proved to be BPH by histopathology. In our series we came across 2 hyperechoic nodules and both turned out to be benign lesions. So our results are closely matching with his results[4]. The mean age of patients with prostatic cancer was 69yrs in **Fred Lee et al** studies. In our study the mean age of patients with prostatic cancer is 66.5yrs.

Katsuto Shinohara et al in their series reported 67% of cancers presenting as hypoechoic lesions, 32% as isoechoic lesions and 1% as hyperechoic lesions[5]. In our studies 5 of the 7 malignant lesions were hypoechoic forming 71% and 2 of 7 were seen as isoechoic lesions forming 29%. We have not come across hyperechoic malignancy in our study.

Most of the study materials showed 70% of carcinomas arise from peripheral zones, 20% in transition zone and l0% in central zone. In our study out of 7 malignant lesions 4 were seen in peripheral zone (57%), 1 in transition zone (15%) and 2 cases were diffuse (38%). This disparity may be because of small representative volume. A tumour occupying most of the prostate may not be visible on ultra sonography. This is called superscan phenomenon, where a tumour virtually replaces the entire prostate so that there is little normal tissue for comparison, as a result the gland has uniform echo pattern and the cancer is not appreciated.

Katsuto Shinohara et al reported that obviously irregular asymmetric gland often signals malignancy even in the absence of an identifiable hypoechic lesion. In our study we identified 2 isoechoic malignancy mainly because of the surface irregularity of prostate[5].

Peter T. Scardino et al said hyperechoic tumours are rare. They explained that they are ductal carcinomas with comedo type tumour nests containing calcifications and necrotic debris causing multiple acoustic interfaces to give a hyperechoic appearance[6]. In our study we have not come across hyperechoic malignancy.

Katsuto Shinohara et al in their series detected 67 cancers by sonography and all 67 were palpable by digital rectal examination[5]. In our study out of 7 cancers 6 were palpable lesions.

Kathryn K. Hodge and **John E. McNeal et al** in their series reported that out of 136 patients subjected for biopsy 86 were positive for cancer (61%). The mean number of biopsy per patient was 7[7]. In our study out of 15 prostatic biopsy we have come across 7 malignancies forming 46%. The mean number of biopsy per patient is 1.

Andrew Doble and **Simon St. C. Carter et al** formulated ultrasound signs in inflammatory prostatic diseases. They are as follows[8]:-

- Hyperdense echoes
- Midrange echoes
- Echolucent zones
- Ejaculatory duct calcification
- Capsular thickening
- Periurethral zone irregularity

We have come across 5 lesions showing hypoechogenicity with midrange echoes out of which 4 were abscesses and 1 turned out to be malignant. (Probably because of necrosis of tumour).

According to **Bezzi M et al** majority of the prostatic malignant lesion shows hypointensity in T2WI[9]. In our study also out of 7 malignant lesion 6 were (85%) of lesion were hypointense in T2WI.

Studies done by **Yu et al** and **McNeal JE et al** shows that MR is more sensitive than TRUS in detection of Transcapsular extension and spread[10,7]. In our study also 2 cases of transcapsular extension was detected by MR where TRUS detected only 1 case and thus the staging was changed from stage 2 to stage 3. Experience with MRI of prostatitis and abscess is limited and reported findings differ. Some investigators report on Inhomogenous appearance of the gland in c/c prostatitis with signal intensity similar to that of normal prostate. Other report that both a/c and c/c prostatitis may show multiple small areas of increased signal intensity scattered throughout the prostate on SE-T2WI. In our study also enlarged prostate with heterogenoussignal intensity were noted.

Studies done by **Shigeno K et al** (BJU-2000) shows the use of CDI when used along with TRUS where hyper vascular malignant lesion, could be located more accurately and it increases the sensitivity and negative predictive value in detecting carcinoma prostate[11]. Inflammatory lesions also show increased vascularity. In our study out of seven malignant lesions 5 showed increased vascularity and four benign lesions also showed increase vascularity, which proved to be of inflammatory cause.

VII. Conclusion

TRUS:-

Transrectal ultrasonography is minimally invasive with no radiation hazard, comparatively cheap modality, to characterize prostatic lesions as benign and malignant and to identify local spread of malignancy for guiding prostatic biopsies. TRUS appeared to be more sensitive than MRI in detecting the lesions, may be because of body coil we used in MR examination.

Hypoechoic lesion distributed in peripheral zones with surface irregularity is a **reliable sign of malignancy** and increased AP dimension causing more rounded configuration of prostate with smooth capsule is a **good sign of benignity**.

In colour Doppler, increased vascularity is seen in both malignant and inflammatory lesions, and it helps to accurately localize the lesions, while performing biopsies.

MRI:-

MRI is also a safe modality without any radiation hazard and is a good modality to localize the lesion in prostatic carcinoma and to know the involvement of other organ and lymph nodes in case of metastatic disease. It is better than TRUS in determining the extent of the disease which also gives the surgeon a three dimensional picture of the lesion before planning for a surgery.

Even with body coil MRI we are able to localize the lesion and extension of the disease to greater extent with additional advantage of larger FOV compared to Endo rectal MRI.

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VIII. Tables

Table – 1:
TRUS vs. HPE correlation

		HPE	
		Malignant	Benign
TRUS	Malignant	6	2
	Benign	1	36

Table – 2:

	Estimate	**95% CI(Confidence interval)**
Sensitivity	85.7	42.1-99.6
Specificity	94.7	82.3-99.3
Correct classification rate	93.3	81.7-98.6
Missed classification rate	6.7	1.4-15.5
Positive predictive value	75	35-97
Negative predictive value	97	86-99
False positive rate	5.2	0.0-18
False negative rate	14.2	0.0-57
Kappa agreement	0.76	0.5-1
Likelihood ratio +	16.3	4.1-64.1
Likelihood ratio -	0.15	0.03-0.93
McNemar's test	χ^2= 0.33	P = 1.00(Not significant)

Table – 3:

		HPE	
		Malignant	Benign
MRI	Malignant	5	-
	Benign	2	38

Table – 4:

	Estimate	**95% (Confidence interval)**
Sensitivity	71.4	29-96
Specificity	100	91-100
Correct classification rate	96	85-99
Missed classification rate	4	1-20
Positive predictive value	100	48-100
Negative predictive value	95	83-99
False positive rate	0	0-9
False negative rate	29	4-71%
Kappa agreement	0.81	0.55-1
Likelihood ratio+	NA	NA
Likelihood ratio –	0.29	0.9-0.99
McNemar's test	χ^2= 2.01	P = 0.48

IX. Figures

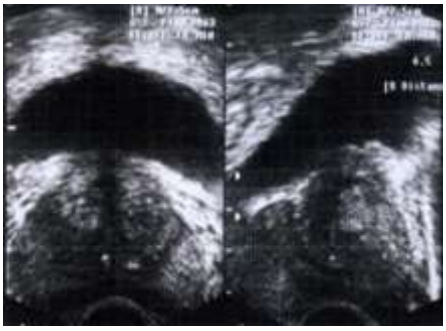

Fig.1: Transverse and Longitudinal Scans of Normal Prostate

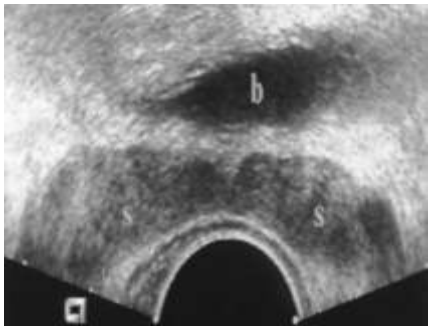

Fig 2: Transverse Scan showing both Seminal Vesicles (bow tie appearance).

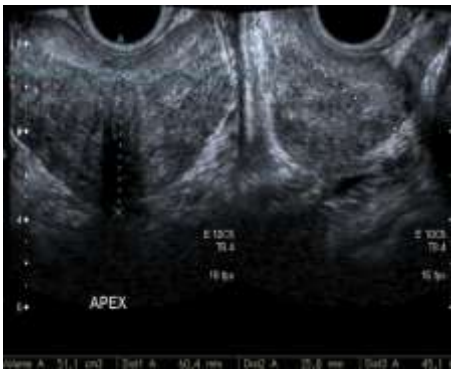

Fig 3: Transverse and Longitudinal TRUS images

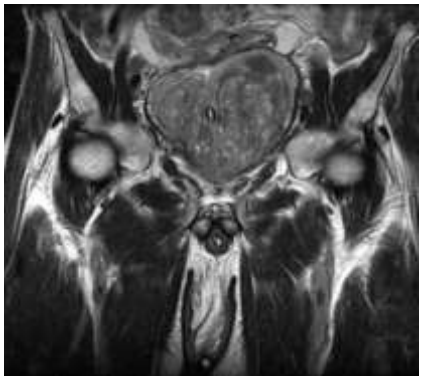

Fig 4: T1W Coronal image showing grossly enlarged prostate showing enlarged Prostate

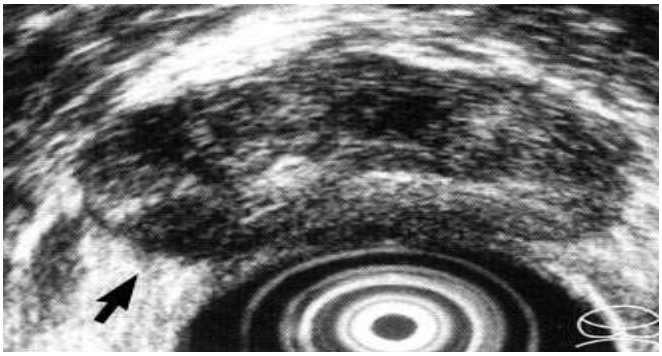

Fig 5: Transverse TRUS scan showing the Extracapsular extension of the tumour

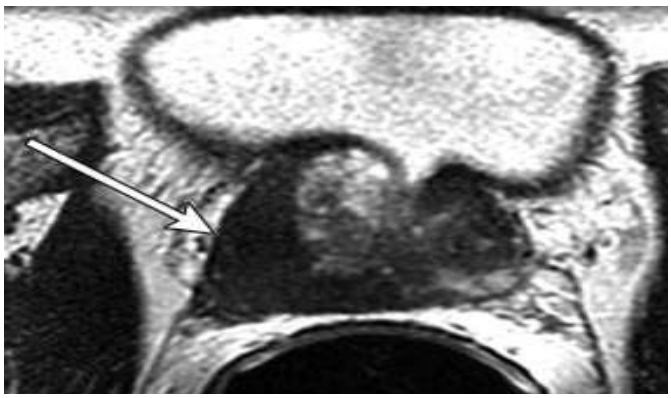

Fig 6: Unenhanced T2-weighted fast spin-echo (5000/96 [effective]) of a 61-year-old man with clinical stage T2a prostate cancer showing loss of normal contour and irregular bulging as evidence of extra capsular disease.

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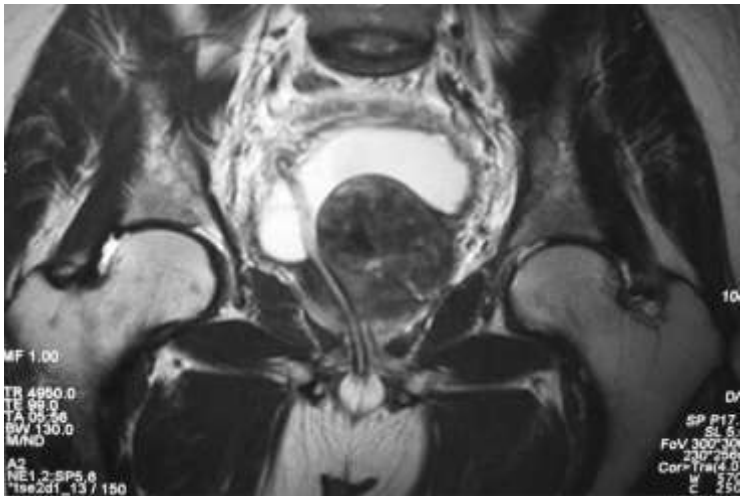

Fig7:T2 Coronal imaging showing carcinoma of prostate with rt femoral and illiac bone metastasis

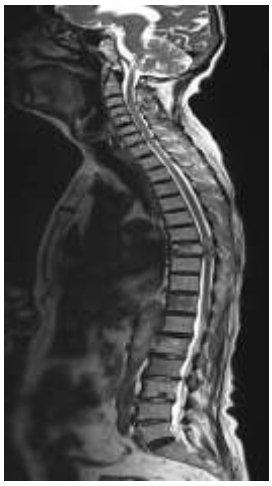

Fig 8: T2WI Sagital image of whole spine with multiple vertebral bodies involvement and partial collapse of T8 vertebral body.

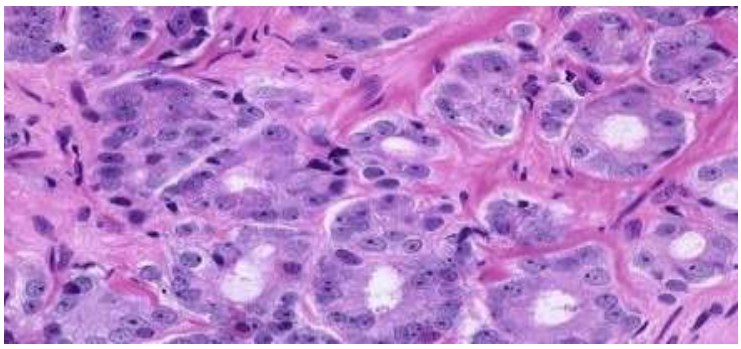

Fig9: Carcinoma Prostate Gleason Score(3), showing abundant amphophilic cytoplasm ,enlarged nuclei with abundant nucleoli

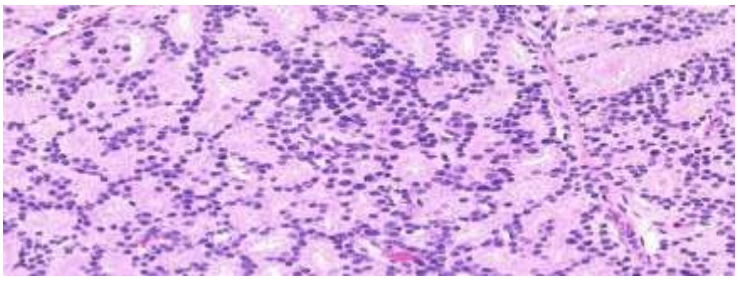

Fig 10: Carcinoma Prostate Gleason Score(4) ,Showing most glands with occluded lumen and the nuclei are hyperchromatic

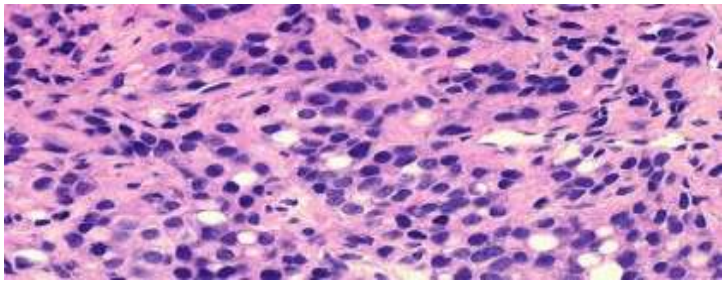

Fig 11: Carcinoma Prostate Gleason Score(5)-- Only a rare gland cells or vacuoles are seen creating a signet ring appearance.

X. Legends

Fig 1: Transverse and Longitudinal Scans of normal prostate.
Fig 2: Transverse Scan showing both Seminal Vesicles (bow tie appearance).
Fig 3: Transverse and Longitudinal TRUS images showing Enlarged Prostate
Fig 4: T1W Coronal image showing grossly enlarged prostate
Fig 5: Transverse TRUS scan showing the Extracapsular extension of the tumour
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